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SUMMARY

1. Tests were conducted, principally by greenhouse plantings, to determine:

(a) The duration of the dormant period in lots of potatoes in which immaturity of various degrees was acquired by several methods and the response of such lots of seed when planted at intervals after both warm and cold storage, and with and without ethylene chlorhydrin treatment (short-time dipping of cut seed pieces in a 5 per cent solution and draining, followed by 24 hours in an air-tight chamber).

(b) The relative efficacy of various recommended methods in terminating the dormant period of Triumph tubers of various degrees of maturity.

(c) The effect of various practices upon the efficacy of the ethylene chlorhydrin treatment.

2. The emergence from the dormant period was found to be a gradual transition and not an abruptly occurring incident. As length of time after harvesting increased, tubers sprouted more promptly when planted and produced more sprouts per seed piece. The number of sprouting eyes per seed piece also increased.

3. In field tests planted in the Bermuda Islands during September the lowest yield increase from ethylene chlorhydrin treated seed was 17.5 per cent and the highest 62.0 per cent. These yield increases are an indication of the relative advances in sprouting produced by the treatment. The most mature potatoes responded most promptly to the treatment.

4. When Nebraska grown potatoes which were approaching the end of their dormant period were planted in January at Hastings, Florida, ethylene chlorhydrin treatment did not appear to hasten emergence or increase yields, but it did increase the number of stems per plant.

5. Potatoes harvested when immature ripened in storage more quickly than did the tubers that were allowed to remain on the vines from one to three months longer. The emergence rate, sprout curve, and number of stems were used as a basis for comparison.

6. Cutting vines early and allowing potatoes to remain in the field till October produced tubers that sprouted more promptly and vigorously than late-harvested stock, but not quite so quickly as early-harvested potatoes.

7. Tubers that were immature because of late planting responded more slowly than mature potatoes in the early part of the season, but sometimes more quickly by the end of the season.

8. Tubers that were immature because of stocks having been planted late sprouted more slowly than those which were immature from having been harvested early, but when both lots were stored the same length of time the former produced more sprouts.

9. By using the ethylene chlorhydrin treatment on seed tubers from lots of seed of various degrees of maturity and from monthly plantings during the winter, the following general results were obtained:

(a) Ethylene chlorhydrin induced prompt sprout growth in all potatoes that had not completed the dormant period. As tubers advanced toward the end of their respective dormant periods the response to the treatment declined.

(b) The greatest growth as measured by rapidity of growth and the number of sprouts was secured from the potatoes that were most mature when treated.

(c) By far the greatest stimulation (when compared with the untreated check) was with the most immature tubers.

(d) The treatment increased the number of sprouting eyes per seed piece and the number of sprouts per seed piece. This increase was very great early in the dormant period but diminished so that it was relatively small when the dormant period ended. This inhibition of apical dominance was apparently the cause of the reduced number of *very early* sprouts (compared with checks) from potatoes that were treated when their dormant period was about completed.

(e) A given lot of potatoes generally produced more early growth when treated and planted on October 15 than did untreated tubers of this same lot, planted on either the same date or later dates, prior to January or February. That is, the treatment accomplished results for which three or four months were required in cold storage.

10. Seed potatoes stored in a cellar, where temperatures were above 45° F., generally (but not always) sprouted more promptly than those held in cold storage (below 42° F.).

11. The ethylene chlorhydrin treatment was found to be the most effective method of initiating early and general sprouting in dormant tubers. Sodium thiocyanate treatment (5 per cent for one hour) gave fairly good results. Removing the periderm had little effect as compared with the two chemical treatments.

12. Various tests indicated quite definitely that the effectiveness of the ethylene chlorhydrin treatment as measured by sprout growth is enhanced by:

(a) Applying the treatment not later than 48 hours, and preferably not beyond 24 hours, after cutting the seed potatoes.

(b) Planting in soil or some other medium with a high moisture holding capacity, in contrast with sand.

(c) Using large seed pieces.

The Effect of Maturity and the Ethylene Chlorhydrin Seed Treatment on the Dormancy of Triumph Potatoes

H. O. WERNER

Western Nebraska dry-land Triumph potatoes (*Solanum tuberosum L.*) vary in maturity at the time of harvest, from some that are very immature to others with vines which are entirely ripe. Variations in maturity may be due to such factors as early frost, drouth, destruction of vines by hail or early blight, time of planting, and strain type (whether early or late maturing). The question of seed maturity and its influence upon duration of the dormant period is of considerable commercial importance, since these potatoes are annually being planted in south Texas as early as December 26 and in southern Florida, Bermuda, and the West Indies as early as September and October.

In order to supply the most satisfactory seed to these regions it is necessary to determine the facts concerning the duration of the dormant period and the sprouting habits of tubers of varying maturity as well as the influence of such factors as time of harvesting and method of storage upon dormancy. Furthermore it is necessary to know how such tubers respond to the more important chemical methods of terminating the dormant period and how the efficiency of said treatments may be increased or impaired by the method of application.

LITERATURE REVIEW

The literature dealing with dormancy in potatoes has been quite completely reviewed in papers by Rosa (7) and Smith (8) to which readers are referred. That which follows is not a complete statement, since the only papers mentioned here are those which raise points pertinent to these studies.

Appleman (1) stimulated growth of immature or unsuberized tubers by removing the periderm around the eyes and by cutting close to the eye or by making wounds close to the eye. He also used several chemicals to break the rest period and reported the most satisfactory results with ethyl bromide.

The effectiveness of ethylene chlorhydrin and the several thiocyanates in stimulating growth in dormant tubers was discovered by Denny (2), who later (4) reported upon various details including the relation of temperature to the effectiveness of and injury by the chlorhydrin treatment.

Smith (8) reported upon the gaseous exchanges which occur in potatoes when treated with ethylene chlorhydrin. He reported much more prompt growth from immature tubers stored in a humid atmosphere than from those stored in a dry atmosphere. He also reported that changes within the tuber which were necessary for sprouting occurred much more rapidly in tubers harvested from green vines than in tubers which remained on the vines until maturity.

In one of the most recent papers dealing with the question of tuber maturity as a factor influencing dormancy, Rosa (7) concluded that the tubers most mature at harvesting have the shortest rest period, as indicated by their more rapid sprouting when planted. He reported further that the rate of sprouting in mature tubers increases rapidly with length of storage but that tubers that are immature when harvested emerge from dormancy more slowly. He considered emergence from the dormant period as a gradual and not a sudden change. He reported marked acceleration in the sprouting of tubers held at high temperatures (28°–30° C.) and some retarding as due to low temperature (4° C.), especially in the early part of the dormant period. He also found that sprout growth was greatly hastened by high humidity when the storage temperature was intermediate (22° C.).

Loomis (5) has called attention to the importance of high storage temperatures and high soil temperatures for early germination of dormant tubers. He also reported that early in the dormant period growth occurred earlier with three- and four-ounce tubers than with those weighing one and two ounces—also that composted soil stimulated early growth of tubers planted in it much more than did sand. He reported no gain in early growth from storage of tubers in damp moss.

EXPERIMENTAL METHODS

The major experiments were planned so as to determine, with the Triumph variety, the significance of tuber maturity *in relation* to (a) the duration of the dormant period, and (b) the response to chemical treatments (principally ethylene chlorhydrin, $ClCH_2CHOH$) that are used for inducing growth in dormant tubers.

Minor experiments were conducted to determine the extent to which various methods of handling seed potatoes before or after planting affect sprout growth, and also to determine the best method of using the ethylene chlorhydrin seed treatment.

SEED STOCKS USED

Tubers of varying maturity were produced for the major experiments by (a) harvesting on different dates (planting date the same); (b) by planting on different dates (harvesting on the same date); and (c) by cutting off vines of growing plants on different dates but harvesting late on the same date.

Only a portion of the experiments and treatments within these experiments are being reported. Those selected are considered most truly representative and suffice to establish the essential facts. Wherever there is any lack of harmony in results from several similar experiments, the condition is discussed.

The experimental material dealing with the maturity question was secured in the following manner. For the 1927-28 preliminary tests (used also for testing several chemical and physical methods of terminating the dormant period) Triumph potatoes from lots of seed planted at Alliance on May 14, June 1, June 16, and July 1 were used. The maturity of these various plantings was estimated at 100, 95, 85 and 15 per cent respectively, when the vines were killed by frost on September 19, after which all lots were harvested.[1]

For the 1928-29 tests the Triumph material produced at Alliance provided lots of tubers of varying maturity as follows:

Series 1—Seed of varying maturity secured by altering harvesting date.

Lot D—Planted May 10, harvested Aug. 2, when 90 per cent mature.

Lot G—Planted May 10, harvested Oct. 2, when 100 per cent mature.

Series 2—Seed of varying maturity secured by early cutting of vines.

Lot H—Planted May 10, vines cut Aug. 2, harvested Oct. 2.

Series 3—Seed of varying maturity secured by altering planting date.

Lot G—Planted May 10, harvested Oct. 2, when 100 per cent mature.

Lot R—Planted July 3, harvested Oct. 2, when 25 per cent mature.

Other lots which were included but for which no data are being presented are: in Series 1, Lot F, harvested Sept. 5, and

[1] "Maturity" was estimated for each experimental lot of seed and was based on the general condition of all vines of the lot on a specific date.

a complete and comparable series, Lots K, L, M, planted June 5; in Series 2, Lot J, planted May 10, vines cut Sept. 4, and Lots N and O, planted June 5, with vines cut Aug. 17 and Sept. 4 and all harvested Oct. 2; and in Series 3, Lots M and P, planted June 5 and 22 and harvested Oct. 2, and another complete set harvested on Sept. 5 instead of Oct. 2.

All of the tubers of the previously enumerated Alliance lots were placed in cold storage at a temperature of 38°–40° F. within one week after harvesting.

In order to determine the effect of higher storage temperatures, 6 lots of Alliance-grown seed were held in a cellar with temperatures of a decreasing order, the mean daily temperatures having been from 75° to 65° F. in August and September; 65° to 56° F. in October; 55° to 45° F. in November; and 45° to 40° F. in December, when the last lots were removed.

The cellar-stored lots and their comparable cold-storage lots were as follows:

Lot S—Planted May 10, harvested Aug. 2. Comparable to cold storage Lot D.

Lot U—Planted May 10, harvested Oct. 2. Comparable to cold storage Lot G.

Other lots which were included but for which data are not shown were Lot T, comparable to cold storage Lot F, harvested Sept. 5, and a series, V, W, and Y, planted June 5 and harvested respectively on Aug. 17, Sept. 5, and Oct. 2.

During the same season (1928-29) tubers varying in maturity due to harvesting date were also used. These were produced on dry land at North Patte. The field plantings were made April 15 and the lots of tubers used were harvested on July 20, August 10, September 1, and October 10. The tubers for the main series of tests with these lines of potatoes were stored in the same cellar used for storing the previously described Alliance potatoes. Another series was stored (from harvest time until December) in a room where the temperature averaged between 70° and 75° F. This experiment is discussed briefly without reporting the data.

For the 1929-30 tests Triumphs grown on dry land near Alliance from stocks planted on May 27 (A) and June 29 (B) were used. The vines of the May stocks (A) were about 65 per cent mature and the June stocks (B) about 8 per cent mature when harvested on October 2. This relative immaturity of both lots was due to the cool, damp weather that prevailed for about 25 days prior to harvesting.

GREENHOUSE TESTING METHODS

In the major experiments the required amounts of seed of the various lots to be used in any test were brought out of storage on the day previous to the testing or planting date, for the greenhouse test. The total number of seed pieces needed from each lot were cut, at the rate of ten seed pieces to the pound. As they were cut an effort was made to see that the seed pieces from each tuber were divided between two piles as nearly as possible. The seed pieces in one were given the ethylene chlorhydrin treatment; the others were used as untreated checks. In all the 1928-29 tests, unless otherwise specified, 50 seed pieces of each lot of seed were used both for the check and treated series. In the 1929-30 tests, 100 seed pieces were used.

The ethylene chlorhydrin treatment used was as follows. Immediately after cutting, the seed pieces were dipped into a 5 per cent commercial (40 per cent) ethylene chlorhydrin solution for about one-half minute, after which they were removed and allowed to drain for a few minutes, when they were placed in small clean muslin sacks, which were stored in a metal, practically air-tight container of about seven cubic feet capacity for 24 hours. Prior to 1929 these treatments were administered in the head house of the greenhouse. As a result of some unavoidably low temperatures encountered there during the midwinter, the efficacy of the tests was sometimes seriously impaired. Consequently in the 1929-30 tests *all* treated potatoes were provided with uniform temperature conditions by being placed inside an uniced refrigerator in a laboratory held at room temperature.

While the treatment was being administered to the one lot of seed, the cut seed pieces of the check were also held at room temperature (70°–75° F.). Immediately after the ethylene chlorhydrin treatment was completed, the treated and untreated pieces were planted in separate flats for sprouting tests. All seed pieces were covered to a depth of about one inch when planted. In 1927 and earlier, sand was used as a testing medium, but in 1928 and later as a result of the work of Loomis (5) and some preliminary tests by the author (Table 6) composted garden soil was used. (Compare Charts 5 and 1 and see Figure 5.)

Prior to 1929-30 all seed pieces of one treatment of one lot of seed were planted in only one flat. This one-flat method was found inadequate because of the difficulty of providing identical temperature and moisture conditions for all lots, which of necessity were in different portions of the greenhouse. In the 1929-30 tests, the 100 seed pieces of each lot of seed were planted in four flats (25 pieces each), and those flats were distributed so as to expose each lot of seed to the various environmental conditions prevailing within the portion of the greenhouse being used for the experiment.

In the seed-maturity experiments, lots of each line were planted at monthly intervals from October to April. The exact dates are given in the tables and charts.

The total number of sprouts above ground in each lot were counted two or three times a week from the time the first sprouts emerged until the 40th day, when the tests were generally terminated, although some were continued for approximately 60 days.

During the winter months the greenhouse temperature was generally lower than in the fall and spring, and the amount of sunlight was considerably less. Consequently in some of the midwinter-month plantings, the growth was slower than during the previous testing periods. In the April test the reduction in growth was due to excessively high temperatures, which are unfavorable to potatoes.

At the termination of each test, notes were taken on each seed piece with regard to the number of eyes producing sprouts, the number of above-ground and below-ground sprouts, and with regard to whether the seed piece was dormant and whether sound or rotten.

EXPERIMENTAL RESULTS

In order to give a reasonably fair and complete description of the response of a lot of seed when planted at intervals during the storage season or when given any treatment designed to initiate growth, it has been found very desirable to present data by several methods. The average number of days necessary for the emergence of a sprout from each seed piece of a lot is a fair means of indicating, not perhaps the end of the dormant period but rather the period when sprout growth can be initiated in a lot of seed potatoes. The total number of sprouts produced by any given number of days is, the author believes, the most effective method of showing the total growth activity and vigor of a lot of seed. This method is used as the basis for a series of sprout-emergence curves presented in this bulletin. The number of eyes per seed piece which produce sprouts or the number of sprouts per seed piece are very satisfactory indicators of the degree of apical dominance within a lot of potatoes at any given time and also, in a general way, of the probable tuber set that can be expected from a lot of potatoes. A few general facts acquired by these several methods of presenting data can quite appropriately be discussed at this point before proceeding to the more detailed discussions.

The emergence data of every lot of tubers tested resulted in essentially the same type of curve, when the total number of sprouts emerging were platted against definite time intervals. This curve was somewhat similar to a typical growth curve with (a) a low initial rise occupying a variable period of time, (b) a more rapid intermediate rise, and (c) a flattening out at the upper end (Chart 1). When a lot of seed was very dormant the curve was relatively flat (Chart 1, Section 1), but with fewer dormant lots, the curve became steeper until finally during the period of greatest activity, it was almost vertical, (Chart 1, Section 5).[2]

The few very early sprouts that occurred in most lots were generally from the eyes located close to the cut surface. Appleman (1) demonstrated that such eyes produce early sprouts because of the increased oxidation of the adjoining tissues. In the case of a very dormant lot of seed potatoes (Chart 1, Rl),[3] the long interval between the emergence of the first sprouts and the period when the greatest number of sprouts were emerging was probably due to the suberization of the cut surfaces, which shut off the oxygen supply and interfered with the necessary oxidation. Growth of most of the sprouts occurred only after the necessary internal changes had been accomplished, gradually and slowly.

The degree of apical dominance within tubers and the eyes of tubers had a very direct bearing upon the shape of the curves. When apical dominance was well established in a given lot of tubers, the curve rose rapidly but flattened out at a relatively low or intermediate point (Chart 1, Section 1). When apical dominance was very poorly developed, the curve was relatively flat in the early period of growth, but then rose rapidly and flattened out at a relatively high point (Chart 1, Section 5). In the case of the apically dominant tubers the number of single-sprout pieces was very great (Chart 2). These single sprouts emerged very quickly. When not apically dominant, many of the seed pieces produced multiple sprouts which competed with each other for food and consequently the emergence of all was somewhat retarded.

RESULTS FROM MAJOR EXPERIMENTS

The length of the dormant period in the various lots of seed

[2] Section number refers to subdivision within the chart. Each subdivision represents data from lots planted on one testing date.

[3] Rl and similar combinations of letters and numbers refer to seed lots and the time when the last test was made in the greenhouse. Rl represents lots from seed planted in the field July 3, harvested October 2, 1928, and then planted for greenhouse test on October 15, while R2 represents seed from the same seed lot but planted November 14, and R3 on December 14, etc.

and the effect of the ethylene chlorhydrin treatment upon the tubers of these seed lots at various periods during the storage season were considered in all tests in these major series.[4] These two phases are discussed in a rather general or summarizing manner, in connection with each lot of seed or series, rather than in detail, since the latter plan would involve much repetition which would be productive of but few additional facts.

Summarizing statements concerning these two phases are therefore inserted in the fore part of this presentation of experimental results, since much of the later discussion might seem incomplete without a knowledge of the facts thus presented.

Duration of the dormant period.—No definite period of time can be named as the length of the dormant period. The duration of the period will depend upon various factors such as tuber maturity at harvest time and temperature and humidity of the storage room. The emergence from the dormant period is a gradual transition and not an abruptly occurring incident.

When each lot of seed was held for an additional month growth was more rapid and the sprout-emergence curve became steeper, provided, of course, that temperature conditions in the greenhouse remained the same.

As the tubers of all lots became older (measuring from harvest time) apical dominance diminished, as did the number of days for the average emergence of sprouts per seed piece, while there was an increase in the number of sprouting eyes and number of sprouts per seed piece (Charts 2 and 3). Almost invariably the sprouting of tubers of any lot of seed varied more from early to late in the storage period than did that of the various lots of seed planted on any one test date.

Effect of ethylene chlorhydrin treatments in the greenhouse tests.—Ethylene chlorhydrin induced prompt growth in all lots of dormant seed potatoes. The difference between the growth of the checks and that of the treated lots of seed

[4] The data from the various lots and treatments are summarized in Tables 1 to 3. The type of vine growth produced by the end of 30 days from most of the lots considered for all except the last few greenhouse testing periods is recorded by photographs (Figure 1 for 1928 and Figure 2 for 1929). The sprouting curves which, in showing the number of sprouts above ground for each seed lot, by any number of days, convey some idea of the total growth activity, are given in Charts 1 and 4 for the 1928 seed lots, and in Chart 5 for 1927.

Since the number of stems and number of sprouting eyes per seed piece are indicators of degree of apical dominance and volume of growth, such data are recorded graphically in Charts 2 and 3.

All these tables, figures, and charts deal with seed lots both *treated with ethylene* chlorhydrin and untreated.

was greatest in the case of the most immature potatoes (Chart 1, A and B, and Tables 1 and 2). The growth curves of the various lots of potatoes held much the same ratio to each other when seed was treated as when not treated. Maturity of dormant seed tubers, while important, was never a limiting factor of consequence; that is, no tubers used were ever too immature to respond very promptly and vigorously to ethylene chlorhydrin treatments. In the tubers no longer dormant, the treatment was of little consequence regardless of the degree of maturity at harvest time.

During the first month or two of the testing season the treated tubers produced the most growth. The number of seed pieces producing plants, the average number of days for emergence, and the total number of stems produced were used to measure the relative response of a lot of seed (Tables 1 to 3 and Charts 2 and 3). As the storage season advanced the treated tubers produced the first plants more slowly than did the comparable checks, but by 20 to 30 days after planting the treated lots were growing much more actively, as shown by the larger total number of stems per lot.

This increase was due to the fact that there were more growing eyes per seed piece as well as more sprouts per seed piece in the treated lots (Tables 1 to 3). The ethylene chlorhydrin treatment reduced the apical dominance of the tubers. This retarded the first sprouts, which were from buds located in apical positions, but it stimulated the growth of the other buds, which of course produced sprouts a little later since non-apical buds (both within tubers and within eyes of tubers) were more dormant at the time they were treated than apical ones and also because there was competition for food on account of the increased number of stems growing from each seed piece. This condition was very noticeable throughout the entire season, from November 15 until the last planting on April 22.

During the early months the treatment more than doubled the number of sprouts per seed piece, but toward spring the difference was considerably reduced (Charts 2 and 3). This early stimulation of more buds per seed piece may be as important an action as the early stimulation of growth in the dormant tubers.

In the ethylene chlorhydrin plats there was more seed-piece rotting than in the check lots (Tables 1 to 4). This was especially the case in early fall and late spring. This was partly due to the higher temperatures, at which ethylene chlorhydrin has been found to cause more damage. At all

Figure 1.—Sprout growth from ethylene chlorhydrin treated (left flat E) and untreated tubers (right flat X) of four lots of potatoes planted on five successive dates at monthly intervals, 1928-29. All photographs were taken about 30 days after planting, except the top row, which were taken at 47 days. All plantings of one lot of seed are in the same vertical lines; all plantings made on one date from different lots of seed are in one horizontal line. The flat numbers are the same as those used for identifying various lots in Chart 3. Test planting dates were: 1, Oct. 15; 2, Nov. 14; 3, Dec. 14; 4, Jan. 14 and 5, Feb. 15. History of seed in field at Alliance: D, planted May 10, harvested Aug. 2; H, planted May 10, vines cut Aug. 2, harvested Oct. 2; G, planted May 10, harvested Oct. 2; R, planted July3, harvested Oct. 2. The taller growth of some check (X) lots compared with their companion treated lots (E) as in flats 1D, 1H, 1G, 3,D, 3H, etc., was sometimes the accidental result of location of flat in greenhouse, but generally the individual plants with fewer shoots per flat grew larger than the E plants which encountered more competition for moisture because of the greater number of shoots per flat. Note the greater density of growth in the E flats (1928-1929 trials, sprout emergence curves in Chart 3).

times the most mature lots appeared to be damaged least by this treatment.

Any given lot of seed generally produced as much early growth when treated and planted on October 15 as did this same lot untreated, when planted in January and February; or, in other words, by the ethylene chlorhydrin treatment the same growth was achieved three or four months ahead of the normal time (Charts 1 and 5). The same relationship was evident with regard to the number of sprouting eyes, or the number of sprouts per seed piece (Charts 2 and 3).

Effect of ethylene chlorhydrin in the field tests.—Some co-operative experiments with Nebraska potatoes of varying maturity, both with and without ethylene chlorhydrin treatments, were conducted in the Bermuda Islands [5] in the fall of 1928 and at Hastings, Florida,[6] in the early months of both 1929 and 1930. The data from these experiments will be reported in a later paper, but it seems appropriate to make a brief statement of the general results at this time.

In the Bermuda Islands all lots of potatoes responded very promptly to the ethylene chlorhydrin treatment, administered either as a gas before shipping the potatoes from Nebraska or as a liquid immediately after the cutting of seed tubers for planting in Bermuda. The tubers were from North Platte, from plantings made April 20th, and were all quite mature. They responded much more promptly and extensively than those from Alliance, which were from late-May plantings and were more immature when harvested Sept. 2nd. The time of harvesting at North Platte (July 20, Aug. 10, Sept. 2) had little influence on emergence time in Bermuda. This was true of both treated and untreated tubers. The ethylene chlorhydrin treatment caused an increase in yield of 18 to 50 per cent with North Platte stock and 17.5 to 62.0 per cent with the Alliance stock. In experiments in 1926, treated seed outyielded untreated by 50 per cent (reported in 1926 report of Dept. of Agriculture, Bermuda, 3, 6).

By the time potatoes are planted at Hastings, Florida, that is, early January, they have almost passed through their dormant period. Tests during two seasons failed to reveal any earlier emergence in any lots of seed as a result of the ethylene chlorhydrin treatment. The treatment, however, did increase the number of stems per seed piece. The seed tubers from the 1928 May plantings in Alliance produced 3.3 per seed piece for the untreated and 4.1 for the treated, while

[5] Work in Bermuda was conducted by E. A. McCallan, Director of Agriculture, partly in cooperation with Dr. F. E. Denny of the Boyce-Thompson Institute for Plant Research, Yonkers, N. Y.

[6] The work at Hastings, Florida, was carried on by Dr. L. O. Gratz, of the Florida Agricultural Experiment Station.

with the seed tubers planted July 3 at Alliance, the untreated produced 3.7 in comparison with 4.2 stems for the treated. Similar differences occurred in 1929. Doubtless due to peculiar seasonal conditions these ethylene chlorhydrin treatments did not bring about any significant yield increases in these Florida tests.

It may be seen that the ethylene chlorhydrin treatment was very practical when given very early after harvest, as indicated by the September plantings in Bermuda. While it has been effective on lots of tubers representing different degrees of ripeness, a considerable degree of tuber maturity would seem to have been desirable. With plantings made later, that is, in January, the treatment did increase sprout growth but there is still some question concerning the effect on yield when used at this date.

When the ethylene chlorhydrin treatment was used in western Nebraska in June in some rather large-scale experiments on cold storage potatoes, it did not alter sprout growth or yields in any perceptible manner. The same can be said of some tests with Irish Cobblers planted near Lincoln in April, 1926.

Relation of tuber maturity to dormancy and sprout growth.—Immature potatoes, as previously stated, were produced by several methods: (1) by early harvesting of early-planted stocks; (2) by early vine cutting of early-planted stocks, and (3) by late harvesting of late planted stocks. The 1928-1929 experiments are used as a basis for the discussion which follows. (For sprout growth see Fig. 1.)

Immaturity due to time of harvesting.—Potatoes that were immature because of time of harvesting produced sprouts more promptly than did the more mature or late-harvested tubers (August 2 D contrasted with October 2 G in May plantings, Chart 1 and Table 1). This difference, which is indicated by the average emergence date and sprout emergence curves, was apparent in each monthly planting from October 15 to April 22, but mostly during the early months. With the immature stock there were also quite generally more sprouting eyes as well as more sprouts per seed piece (Charts 3 and 4). The response of a lot of seed harvested on the intermediate date (September 5) was quite generally intermediate between that of the stock harvested in August and October. In a similar test of lots of seed planted on dry land at North Platte in April, 1929, and harvested on July 20, August 10, September 10, and October 10, the response was essentially in the same manner; that is, on any one date the early-harvested stocks which were most immature when harvested grew most promptly, and the late-harvested stocks which were most mature when harvested grew most slowly (as measured by sprout emergence curves), and they produced the fewest stems per seed piece.

When tubers which had been stored the same length of time were compared from both lots—that is, when the October testing of August harvested stock (D 1) was compared with the December testing of October harvested stocks (G 3) etc.—the mean plant-emergence date from the seed pieces of immature stocks (early harvested) was generally still earlier than that of the mature stocks (Table 1).[7] The growth curve of the early-harvested lot rose more rapidly in the first portion of the sprouting period but at about 25 or 30 days it flattened out at a lower point than did the curve of the late-harvested stocks (Chart 1). The mean number of sprouts per seed piece as well as the number of multiple-sprouting seed pieces was by far the highest in the late-harvested (field-mature) stocks (Charts 2 and 3 and Table 1). All these differences diminished as the storage season advanced. Apparently when maturity was obtained by late harvesting, and tubers were stored the same length of time as were those harvested early, those that remained on the vines the longest made the most desirable growth and were the least apically dominant but did not produce the first sprouts quite so early.

Immaturity due to early vine cutting.—Potatoes which were immature because the parent vines had been cut off at the surface of the ground on August 2—May 10 planting harvested October 2 (H)—sprouted more promptly during October and November than those which remained on the undamaged vines until harvested in October (G), (Table 1 and Chart 1).

The average sprouting time was more nearly the same for both lots beginning with the December tests, but the cut-vine stocks (H) still continued to be slightly earlier. The cut-vine stocks (H) also produced slightly more sprouts per seed piece than did the mature-vine, late-harvested stocks (G).

The average sprouting dates of these August 2 cut-vine, field-stored potatoes (H) were generally later than those of the tubers harvested on the same date(D), but due to the tendency toward a greater number of sprouts per seed piece (Table 1 and Chart 2) the sprouting curves from the tubers of the cut-vine lot were generally the higher (Chart 1).

[7] Other comparable lots are D2 with G4, D3 with G4, D4 with G6, and D5 with G7.

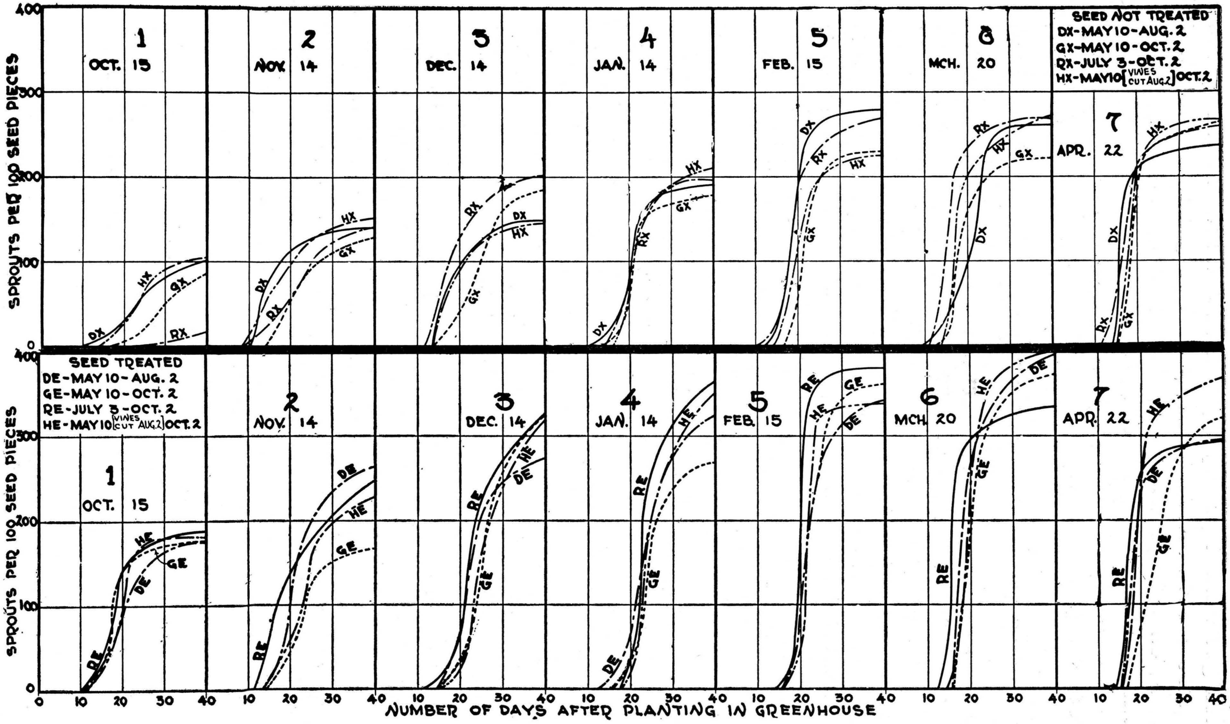

Chart 1.—Curves showing sprout emergence rate from seed potatoes varying in degree of maturity and planted at monthly intervals from October, 1928, (1) to April, 1929, (7) both with and without treatment with ethylene chlorhydrin before planting. (See Tables 6 and 7 and Figure 4.)

TABLE 1.—*Summary of sprouting record of dry-land (Alliance) seed stocks planted on May 10, 1928, but harvested on different dates—50 seed pieces used in each lot*

Date planted in green house	Percentage of seed pieces producing sprouts			Average number of days for sprout emergence[1]			Mean number of sprouting eyes per seed piece[2]			Mean number of stems per seed piece			Percentage of seed pieces rotting		
	(D) Harvested Aug. 2	(H) Vines cut Aug. 2, harvested Oct. 2	(G) Harvested Oct. 2	(D) Harvested Aug. 2	(H) Vines cut Aug. 2, harvested Oct. 2	(G) Harvested Oct. 2	(D) Harvested Aug. 2	(H) Vines cut Aug. 2, harvested Oct. 2	(G) Harvested Oct. 2	(D) Harvested Aug. 2	(H) Vines cut Aug. 2, harvested Oct. 2	(G) Harvested Oct. 2	(D) Harvested Aug. 2	(H) Vines cut Aug. 2, harvested Oct. 2	(G) Harvested Oct. 2
UNTREATED CHECKS															
Oct. 15.....	98	100	88	28.7	28.6	32.7	1.10	1.04	1.02	1.10	1.06	1.02	2	0	4
Nov. 14.....	100	100	100	16.2	18.9	21.6	1.14	1.14	1.12	1.40	1.50	1.24	0	0	0
Dec. 14.....	100	96	98	14.8	20.9	19.2	1.34	1.25	1.47	1.44	1.54	1.86	0	4	0
Jan. 14.....	100	100	94	15.9	21.1	21.2	1.50	1.52	1.45	1.92	2.14	1.94	0	0	4
Feb. 15.....	100	98	98	17.8	20.3	21.4	2.08	1.43	1.50	2.74	2.20	2.27	0	0	0
Mar. 20.....	100	96	98	15.2	18.0	16.1	1.94	1.94	1.76	2.60	2.63	2.20	0	4	2
Apr. 22.....	96	100	94	17.6	17.6	18.2	1.95	2.02	2.03	2.51	2.64	2.68	0	0	6
SEED PIECES TREATED WITH ETHYLENE CHLORHYDRIN															
Oct. 15.....	86	100	84	17.6	24.1	18.7	1.58	1.28	1.50	2.17	1.82	2.14	14	0	16
Nov. 14.....	98	88	82	20.4	21.5	22.5	1.86	1.66	1.36	3.06	2.59	2.17	0	10	16
Dec. 14.....	100	100	98	21.4	24.6	24.8	2.00	1.80	1.90	3.14	3.20	3.35	0	0	0
Jan. 14.....	100	100	100	24.2	22.8	23.0	2.18	2.16	1.98	3.28	3.48	2.74	0	0	0
Feb. 15.....	100	100	96	21.6	22.6	21.5	2.12	1.96	2.07	3.34	3.36	3.56	0	0	2
Mar. 20.....	100	96	100	17.7	18.0	18.9	2.36	2.19	2.08	3.90	4.00	3.68	0	4	0
Apr. 22.....	97	92	58	18.5	17.4	18.9	1.62	2.24	1.81	3.08	3.97	3.23	0	0	42

[1]Average number of days for sprout emergence is based on all seed pieces producing sprouts, *not* on all seed pieces planted.

[2]"Sprouting eyes" refers to eyes the sprouts from which were through the soil when the test was terminated.

TABLE 2.—*Summary of sprouting record of dry-land-grown seed stock from July 3 (R) planting in 1928 when tested at monthly intervals during dormant period, without and with ethylene chlorhydrin treatment—record based on 50 seed pieces*

Date planted in greenhouse	Percentage of seed pieces producing sprouts		Average number of days for sprout emergence		Mean number of sprouting eyes per seed piece		Mean number of stems per seed piece		Percentage of seed pieces rotting	
	Check	Treated	Check	Treated	Check	Treated	Check	Treated	Check	Treated
Oct. 15	26[1]	92	40.7	15.0	1.08	1.50	1.08	2.20	0	8
Nov. 14	98	100	21.0	18.1	1.18	1.50	1.44	2.94	0	0
Dec. 14	94	100	16.6	21.4	1.49	1.80	2.15	3.38	6	0
Jan. 14	100	100	21.6	22.8	1.28	1.86	1.96	3.76	0	0
Feb. 15	100	96	18.8	20.2	1.84	2.08	2.60	3.79	0	0
Mar. 20	96	96	15.1	16.1	1.75	1.96	2.68	3.51	0	2
Apr. 22	96	100	17.3	17.9	1.81	2.05	2.58	2.93	4	0

[1]Fifty-six per cent of the seed pieces were still dormant 45 days after the sets were planted.

Apparently cutting the vines early and storing the tubers in the field (H) was a satisfactory practice, for it resulted in sprouting curves higher than those of field-matured tubers (G) and very comparable to those of early-harvested stocks (D). The average sprouting dates were, however, generally closer to those of the late-harvested (G) than to those of the early-harvested stocks (D).

With another line of tubers produced by plants that had the vines cut off at the surface of the soil on September 4 (J), the responses were intermediate between those of the vines cut August 2 (H) and the vine-matured stocks harvested October 2 (G).

Evidently the maturation processes essential for the renewal of growth in tubers were accomplished more quickly when tubers were isolated from growing vines than when allowed to remain on the active vines for a long period of time, or till the latter were mature.

When tubers of late-harvested lots (G) were stored for two months longer than the tubers harvested the same day but above which the vines had been cut early (so as to be removed from the vines the same number of days—comparison such as G3 with H1 or G4 with H2) not only did the plants generally emerge earlier but they produced higher growth curves and more sprouts per seed piece (Table 1 and Charts 1 and 2). The two months of additional vine maturity was advantageous.

Immaturity due to late planting.—When immaturity of seed tubers was due to late planting (July 3), sprouting was delayed considerably more by October 15, 13 days after harvesting, than with May 10 planting (Chart 1). However, on November 14 and on December 14 this immature stock was sprouting about as promptly and vigorously as the mature stock. After a rest of 135 days (February 15) and longer, the immature stock was always ahead. The immature stock always produced more shoots per seed piece than did the mature stock (Tables 1 and 2 and Chart 2).

The growth responses of lots of seed from June 5 (M) and June 20 (P) plantings, representing intermediate degrees of maturity, were generally of an intermediate degree throughout the testing period.

Evidently a certain degree of maturity was essential for sprout growth, but apparently this was adequately acquired in these late-planted 1928 stocks during the first 43 days after harvest.

The early-planted seed stocks in both 1927 and 1928 produced relatively very mature tubers, while those from the

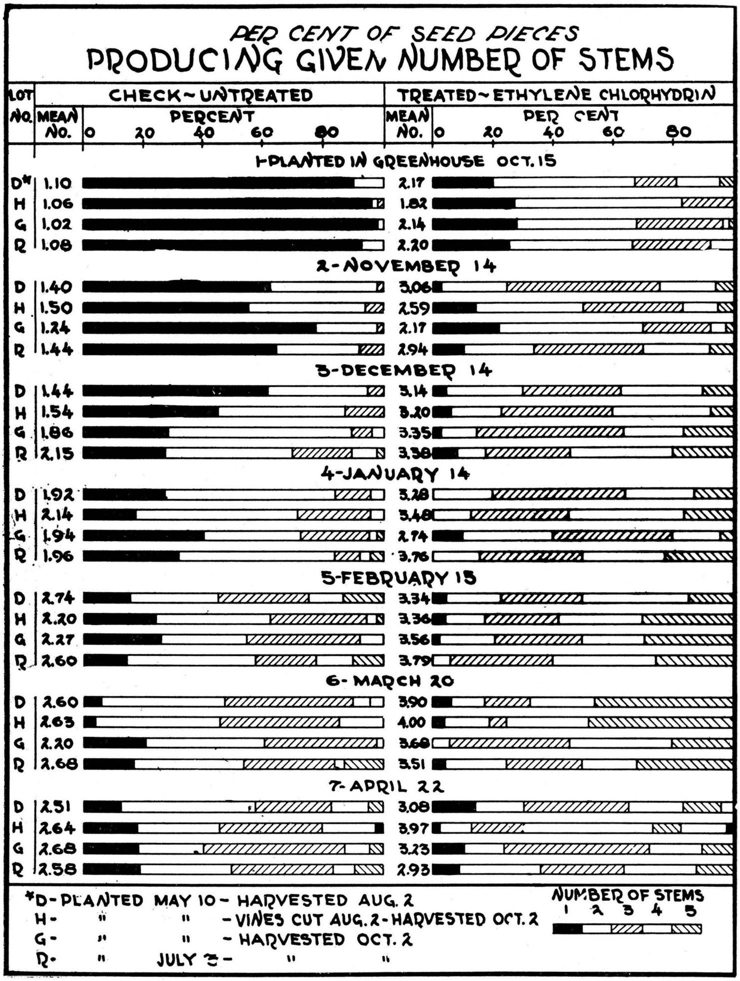

Chart 2.—Distribution of seed pieces producing given numbers of stems for various lots of seed planted at monthly intervals from October, 1928, to April, 1929. Apical dominance was lost and consequently the number of plants with larger numbers of stems was increased as the storage period was prolonged or when the ethylene chlorhydrin seed treatment was used.

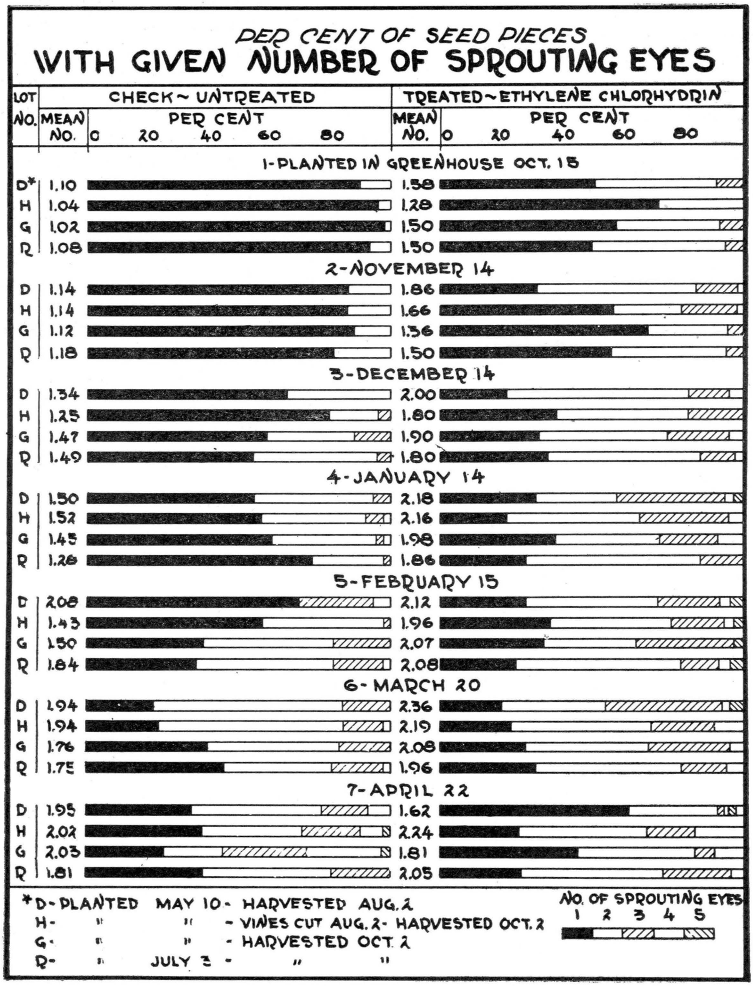

Chart 3.—Distribution of seed pieces according to the number of sprouting eyes for various lots of seed planted at monthly intervals from October, 1928, to April, 1929.

late-planted stocks were not entirely immature, the vines showing signs of maturity. However, the 1928 stocks were probably the most mature of any used during the three years. On the other hand, in 1929 the tubers from early-planted stocks (A) (May 27) were taken from vines that were only partly ripe, while the vines of the late plantings (B) (June 29) were still entirely green and showed no signs of maturity.

Figure 2.—Sprout growth of four lots of Triumph seed potatoes. Seed pieces were treated with ethylene chlorhydrin (A) in comparison with the check (C) the seed pieces of which were soaked in water for one hour before planting. The photographs were taken December 23. In 1927 these various lots had produced less growth at the end of 46 days than did comparable lots in 1928 (2G and 2R for May and July) or 1929 (Lots 2A and 2B) in 30 days. This difference was probably due to the fact that sand, a less satisfactory sprouting medium, was used in 1927. As maturity of seed decreased the sprout growth was also less in both treatments. (For sprout emergence curves see Chart 1.)

In the series of tests conducted during the winter of 1927-28, when potatoes from Alliance-grown stock planted in the field at intervals from May 14 to July 1 were tested by monthly plantings from October to March, the mature, early-planted stock was habitually the first to sprout (Chart 5, A and B, Fig. 2). (The slower growth rate and smaller number of sprouts per 100 seed pieces shown in the 1927-28 tests are undoubtedly due to the use of sand in sprouting the seed pieces. See Table 6 and Figure 5.)

In the 1929-30 testing period the late-planted (immature) stocks not only emerged more slowly on each date but their growth curves were practically always below those of the early-planted stocks, as was also the final number of sprouts per seed piece (Table 3 and Figure 3). This was undoubtedly due to the fact that in 1929 the tubers from late-planted stocks were not so completely developed as in former years and that tubers from the early plantings were not so mature as in former years because of later planting and better fall growing conditions.

It is believed that the earlier sprouting of late-planted 1928 stock (R) late in the storage season is due to the fact that the tubers of the early-planted stocks (G) were much more mature when harvested and consequently they reached the period of highest efficiency (regarding prompt growth) at an earlier date than did the late-harvested stocks. The premature death of the vines due to drouth rather than ordinary senility may have caused abnormal conditions within these early-planted, late-harvested tubers (G). During the three years at harvesting time, the growth activity in plants from late plantings was least in 1928, whereas it was the greatest in 1929. This probably had much to do with the development of the buds within the eyes of the tubers.

Immature tubers produced by late planting (R) did not produce sprouts as promptly as did the stocks which were considered immature because of early harvesting (D) or early vine cutting (H). However, the tubers from early cut-vine stocks had the lesser advantage (Tables 1 and 2 and Chart 1). By the end of the period—March 20 and April 22—the late-planted and late-harvested tubers (R) were growing more promptly and vigorously than those of the other lots (Charts 1, 4, and 5). The length of time the tubers were off the growing vines or in storage appeared to be the factor limiting promptness and amount of sprout growth—that is, the tubers with the longest rest period responded most promptly, until the period of maximum activity was reached at about 6 to 7 months, when an increased length of time ceased to be advantageous.

A certain minimum degree of maturity was necessary for prompt growth early in the fall. This maturity may have been of an anatomical as well as biological or chemical nature. It was apparently acquired more rapidly when the tubers were off the vine (D or H) than when they remained attached to a growing vine (G).

The 1928 July-planted stock (R), stored two months longer before planting in the greenhouse than those from the May-

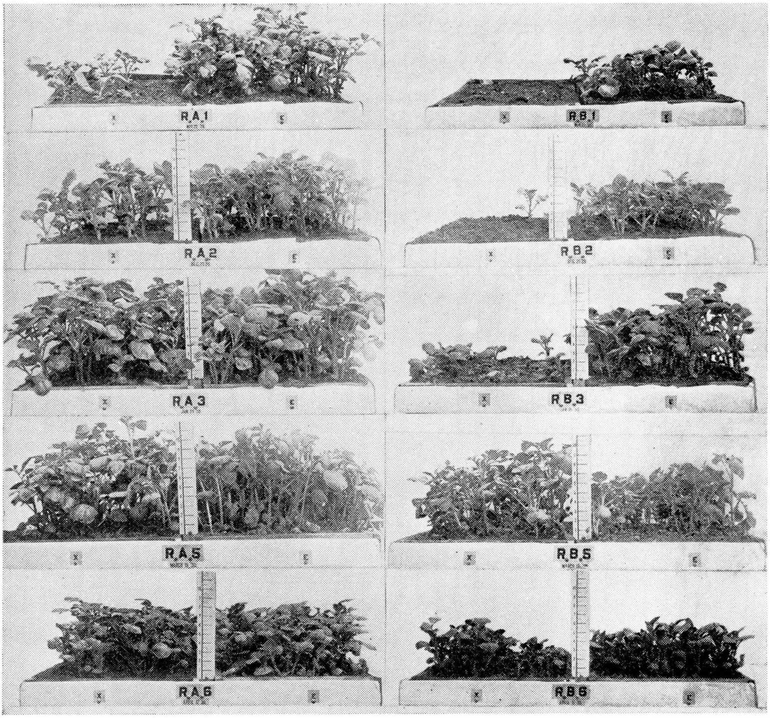

Figure 3.—Sprout growth 30 days after planting from mature (RA) and immature (RB) seed potatoes (parent stocks planted May 27 and June 29, 1929 respectively). Photographs taken 30 days after planting dates which were the 14th of each month from October to March (except February). Check in left flat, ethylene-chlorhydrin-treated stock in right flat.

planted stock (G) (comparisons such as R3 with G1, R4 and G2), emerged most quickly and produced the highest sprout curves and decidedly more sprouts per seed piece (Tables 1 and 2 and Chart 1). Two additional months of storage in the case of Lot R were more beneficial than the two additional months acquired by Lot G in the field, on the growing plant. With the 1927 and 1929 tubers an additional period in storage sufficient to total the same number of days from planting time to testing time did not result in the late-planted stock surpassing the early stock, although the latter was practically equalled frequently (Chart 5 and Table 3).

A comparison of data from tubers of each lot stored for the same number of months (D1 with R3, D2 with R4, etc.) indicates that the tubers produced in the early part of the

TABLE 3.—*Summary of sprouting record of early and late-planted Triumph seed potatoes grown on dry land at Alliance in 1929, when planted at monthly intervals throughout the dormant period—100 seed pieces used in each lot*

Date of greenhouse test planting	Percentage of seed pieces producing sprouts, parent stock planted		Average number of days for sprout emergence, parent stock planted		Mean number of sprouting eyes per seed piece, parent stock planted		Mean number of stems per seed piece, parent stock planted		Percentage of seed pieces rotting, parent stock planted	
	(A) May 27	(B) June 29	(A) May 27	(B) June 29	(A) May 27	(B) June 29	(A) May 27	(B) June 29	(A) May 27	(B) June 29
UNTREATED CHECKS										
Oct. 14	90[1]	21[2]	28.2[4]	27.4[4]	1.33	1.24	1.04	1.09	4	3
Nov. 14	100	82[3]	16.4	22.5[4]	1.58	1.11	1.24	1.14	1	8
Dec. 14	100	100	14.8	26.5	1.66	1.17	1.36	1.14	0	3
Jan. 14	100	99	15.6	19.1	2.53	1.42	2.07	1.13	0	0
Feb. 14	100	100	13.7	15.7	2.25	1.84	2.46	1.71	1	7
Mar. 14	100	100	18.2	18.5	1.93	2.06	2.12	2.27	1	16
SEED PIECES TREATED WITH ETHYLENE CHLORHYDRIN										
Oct. 14	100	89	14.3	24.5	3.01	1.82	2.92	2.00	0	31
Nov. 14	100	100	18.3	20.7	2.78	1.85	2.60	1.94	1	17
Dec. 14	99	99	15.7	20.4	2.70	2.20	3.02	2.05	0	7
Jan. 14	100	100	14.6	16.5	3.35	2.51	3.55	3.32	0	9
Feb. 14	100	77	14.4	18.5	3.33	2.30	4.15	3.62	0	47
Mar. 14	100	92	15.1	16.0	2.68	2.50	3.90	4.63	0	29

[1]Six per cent of seed pieces dormant at end of 40 days.

[2]Thirty-four per cent of seed pieces dormant at end of 40 days.

[3]Two per cent of seed pieces dormant at end of 40 days.

[4]These averages too low because of not considering high percentage of tubers that were still dormant at end of 40-day test period.

TABLE 4.—*Performance of early- and late-harvested dry-land-grown tubers planted at monthly intervals after harvesting, with storage in a warm cellar—1928 crop—comparable to Lots D and G in Table 1*

Date planted in greenhouse	Percentage of seed pieces producing sprouts, parent stock harvested		Average number of days for sprout emergence, parent stock harvested		Mean number of sprouting eyes per seed piece, parent stock harvested		Mean number of stems per seed piece, parent stock harvested		Percentage of seed pieces rotting, parent stock harvested on	
	(S) Aug. 2	(U) Oct. 2	(S) Aug. 2	(U) Oct. 2	(S) Aug. 2	(U) Oct. 2	(S) Aug. 2	(U) Oct. 2	(S) Aug. 2	(U) Oct. 2
					UNTREATED CHECKS					
Oct. 15..........	32	86	33.5	23.9	1.00	1.00	1.18	1.16	68	14
Nov. 14.........	100	98	31.6	17.4	1.14	1.27	1.18	1.33	0	2
Dec. 14.........	100	100	21.6	15.8	1.14	1.40	1.40	1.60	0	0
					SEED PIECES TREATED WITH ETHYLENE CHLORHYDRIN					
Oct. 15..........	36	60	26.2	23.9	1.28	1.07	1.67	1.60	64	40
Nov. 14.........	100	100	26.7	25.6	1.34	1.92	1.86	2.44	0	0
Dec. 14.........	100	100	24.7	19.2	1.74	1.40	2.52	2.60	0	0

growing season (D) when weather was warmer (tubers consequently more elongated) produced sprouts earlier, especially early in the fall, but they produced less total growth and fewer stems than did the tubers produced late in the season (R). In this instance the age of the parent plants and the storage periods were about the same. When a similar comparison is made with the tubers from the August 2 cut-vine set (H), the late-planted stock (R) is found to have been ahead (Chart 1). Early production and field storage were not equal to late production and cold storage.

Effect of storage temperature on tuber dormancy.—In 1928, lots of seed from May-planted tubers, harvested at different dates, were stored in a potato cellar (58° to 45° F.) at harvest time for the purpose of comparison with cold-storage stock (42° F.). On each of the first three monthly planting dates, samples were removed for testing.

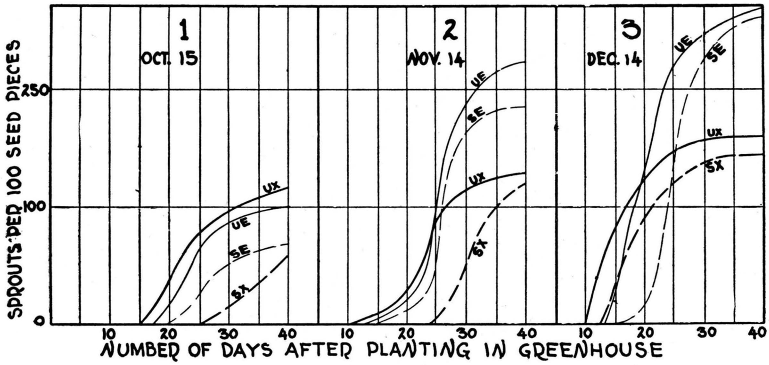

Chart 4.—Curves showing sprout emergence rate from cellar-stored potatoes of several lots of seed when planted in October, November, and December, both with (E) and without (X) ethylene chlorhydrin seed treatment. Seed stock from May 10 plantings (Lot S harvested August 2 and Lot U harvested Oct. 2, 1928) can be compared with Lots D and G of Chart 1.

The higher storage temperature delayed the sprouting of early-harvested lots. The cellar-stored lots (S) harvested August 2nd had sprouted more slowly in October and November than the cold-storage lots (D) (Table 4 and Chart 4). By mid-December the sprouting of both lots was about the same. Possibly the delay in the early-harvested, warm-stored lots was due to a period of induced and deeper dormancy from which emergence was slow and gradual (White, 9, and Denny, 2).

The lot harvested October 2 (U) grew much more promptly when stored in the cellar than when placed in cold storage (G). In fact the cellar-stored potatoes of this lot grew at about the same rate as, or more promptly than, did the early-harvested, cold-storage lots. The different behavior of this lot of seed may have been due to a greater degree of dormancy at harvesting time, rendering it less susceptible to factors which may have caused a period of induced dormancy in the other (early-harvested) stocks.

Potatoes harvested on September 5 performed almost identically like those harvested August 2. (On September 5 early plantings were maturing rapidly.)

Another set of tests was conducted with potatoes planted on June 5, 1928. With these potatoes the cellar-stored tubers sprouted more promptly on each date than the cold-storage tubers.

The amount of seed-piece rotting was very much greater with *all* cellar-stored seed planted in October than with cold-storage seed.

With potatoes grown at North Platte and planted in April and harvested at intervals from July 20 to September 1, the tubers of the warm-room storage grew more promptly on each fall planting date than did the cellar-stored tubers.

The higher storage temperature generally caused more prompt growth during the early-storage months. It also frequently caused an increase in the number of stems per seed piece, but, as has been shown, under some conditions high storage temperature retarded the prompt growth of some lots of seed.

RESULTS FROM MISCELLANEOUS EXPERIMENTS

Methods of terminating the dormant period.—Several methods of inducing growth in dormant tubers were tested on potatoes which had been grown by planting on different dates on dry land at Alliance in 1927. These tests were conducted at different dates from October 10 to February 16. The methods tested were the following:

A. Standard 5 per cent ethylene chlorhydrin dipping method with cut seed.
B. Dipping cut seed for one hour in a 5 per cent solution of sodium thiocyanate.
C. Soaking cut seed in water for one hour immediately after cutting (as a proper check on B).
D. Periderm removed around all the eyes of all seed pieces.
E. Check—planted at once after cutting without any treatment.

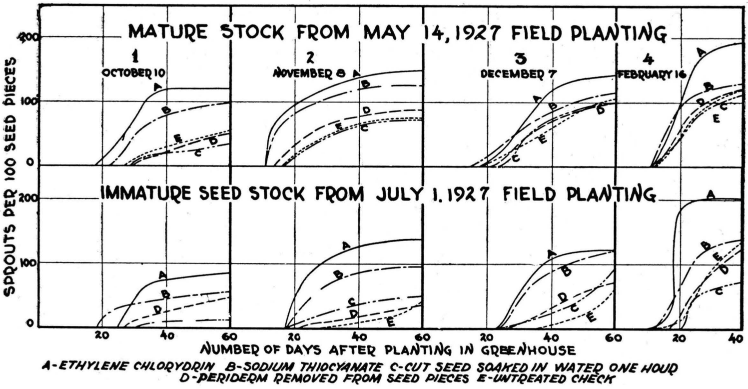

Chart 5.—Sprout emergence curves for mature and immature potatoes (from May 14 and July 1, 1927, field plantings) when cut seed was treated before planting as indicated. Planting dates for tests were: 1, October 10; 2, November 8; 3, December 7; 4, February 16.

The experimental unit consisted of 50 seed pieces from each lot for each treatment. Data for May and July seed stocks as tested on four dates are graphically shown by sprout emergence curves in Chart 5.

The seed lot given the ethylene chlorhydrin treatment (A) grew most promptly and vigorously with the greatest number of stems per seed piece (Chart 1). The response to sodium thiocyanate (B) was somewhat less prompt and less complete. Soaking the seed pieces in water for one hour (C) generally delayed emergence, the growth rate being slower than for the checks. This method seemed to hasten suberization of the cut surface, thus shutting off the oxygen supply and thereby preventing growth or even bringing about a period of induced dormancy. The percentage of seed pieces rotting was higher by this method than by any other. Removing the periderm (D) caused somewhat earlier growth than in the check (E) but the response was much slower than with the chemical treatments. If there was any difference the scraping method was less effective in the early part of the storage period (October 10) than later in the winter when tubers were more mature.

The response of both mature and immature potatoes to these treatments was very similar (Chart 5 and Figure 3). The principal difference was the relatively greater effectiveness of the chemical treatments with immature tubers, in contrast with the other methods, throughout the entire testing period, but especially so early in the period (October).

TABLE 5.—*Effectiveness of ethylene chlorhydrin treatment on suberized seed pieces*

Time seed was cut in advance of treatment[1]	Percentage of seed pieces producing sprouts		Av. number of days for sprout emergence		Av. number of eyes producing sprouts per seed piece		Av. number of sprouts per seed piece		Percentage of seed pieces rotting	
	Check	Treated	Check	Treated	Check	Treated	Check	Treated	Check	Treated
At once........	96.7	100.0	29.3	23.0	1.21	1.70	1.31	2.33	0	0
3 hours........	86.7	100.0	28.7	26.3	1.19	1.43	1.42	2.03	6.7	0
9 hours........	93.3	100.0	26.4	23.3	1.18	1.77	1.21	2.67	6.7	0
24 hours........	93.3	100.0	33.2	23.2	1.11	1.50	1.14	1.90	3.3	0
2 days........	86.7	93.3	34.1	28.8	1.04	1.39	1.04	1.71	6.7	3.3
4 days........	93.3	93.3	31.3	31.1	1.43	1.29	1.50	1.50	0	6.7
6 days........	90.0	73.3	38.1	34.8	1.15	1.32	1.18	1.41	3.3	16.7

[1]All lots were planted 24 hours after treated and the checks were held in air under same temperature conditions during the treating interval. The test was terminated at the end of 44 days.

The ethylene chlorhydrin treatment was considered the most effective method and consequently was adopted for later tests.

Effectiveness of the ethylene chlorhydrin treatment on suberized seed pieces when used at intervals after cutting the seed potatoes.—Triumph seed potatoes were cut at various intervals of time ahead of planting, or of treating with ethylene chlorhydrin, so as to determine the effect of the healing or suberization processes on sprout growth. Fifty seed pieces were used from each lot for each treatment. This test was conducted in November, 1928, with tubers that would not have sprouted completely until January. When planted within 33 hours after cutting, sprout growth was not delayed, but when this was increased to 48 hours or more the emergence of sprouts from check-lot seed pieces was materially delayed (Table 5. Chart 6, and Figure 4). When treated with the ethylene chlorhydrin the effectiveness of the treatment was apparently not decreased until seed treating was delayed beyond 24 hours—i.e., to 48 hours after cutting the seed. The effectiveness was further reduced as the treatment was delayed to four and six days respectively; however, even then the average emergence date was advanced ahead of that of the untreated check.

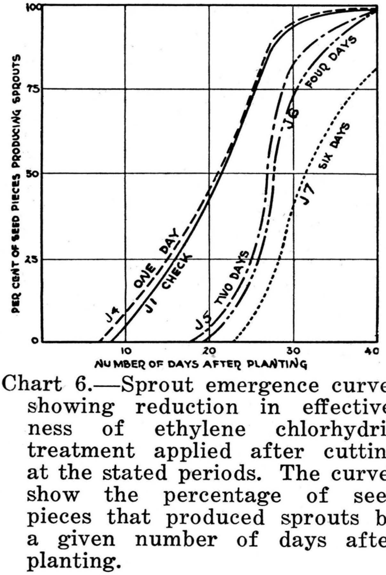

Chart 6.—Sprout emergence curves showing reduction in effectiveness of ethylene chlorhydrin treatment applied after cutting at the stated periods. The curves show the percentage of seed pieces that produced sprouts by a given number of days after planting.

Influence of soil in which seed pieces are planted.—In early November, 1928, cut seed pieces, both treated and untreated, were planted in the various synthetic soils described in Table 6.

As the moisture-holding capacity of a soil increased, dormant seed potatoes sprouted more promptly. When seed pieces were treated with ethylene chlorhydrin the same order applied in a general way, there having been some slight shifting which can be accounted for partly by error due to the

Figure 4.—Sprout growth 30 days after planting from seed pieces treated with ethylene chlorhydrin at specified intervals after cutting. Lot J1 was treated immediately after cutting, while J2, J3, and J4 were treated 3, 9, and 24 hours respectively after cutting and J5, J6, and J7 were treated 2, 4, and 6 days after cutting. Thirty seed pieces were used in each test. The treated lot is to the left (marked E) in each flat while the untreated check cut at the same time but not treated is to the right.

small number of pieces. The sprout growth was most prompt from the lots planted in the 100 per cent compost soil, followed by the 67 per cent compost, the sphagnum moss, the garden soil, the 33 per cent compost, and then the pure sand and wood shavings lots, the slowest of this series (Figure 5 and Table 6).

The use of pure garden soil (silt) without composting resulted in slow growth, probably because of the reduced aeration and greater physical resistance. Sawdust and wood shavings were less satisfactory than the composted soil. Sphagnum moss was a very satisfactory medium.

The medium in which seed pieces are planted is an important factor in speed of growth of untreated seed pieces, but it apparently is of less significance when the ethylene chlorhydrin treatment is used. Ethylene-chlorhydrin-treated pieces planted in a medium such as sand respond more slowly to growing conditions than do untreated pieces planted in composted soil or sphagnum moss.

Relation of size of seed piece to sprout growth of dormant potatoes.—Pieces weighing 15, 30, and 60 grams (100 pieces of each) were cut from a uniform lot of tubers, and half the pieces of each size were treated with ethylene chlorhydrin on October 31, 1929, to determine the effect of the treatment on seed pieces of different sizes.

TABLE 6.—*Growth response of seed pieces planted in various types of soil—30 seed pieces in each treatment*

Type of soil	Percentage of seed pieces producing sprouts		Av. number of days for sprout emergence		Mean number of sprouting eyes per seed piece		Mean number of sprouts per seed piece		Percentage of seed pieces rotting	
	Check	Treated	Check	Treated	Check	Treated	Check	Treated	Check	Treated
Garden soil	93.4	66.7	26.3	25.7	1.14	1.50	1.29	2.00	6.7	33.3
100 per cent compost	76.7	80.0	22.7	19.6	1.26	1.42	1.35	2.08	23.3	20.0
67 per cent compost, 33 per cent sand	100.0	96.7	23.9	21.7	1.03	1.65	1.07	2.75	0	3.3
33 per cent compost, 67 per cent sand	100.0	86.7	26.5	26.5	1.07	1.34	1.17	1.96	0	13.3
100 per cent sand	86.7[1]	100.0	33.8	25.4	1.04	1.40	1.12	1.93	0	0
Sawdust	100.0	100.0	28.5	25.7	1.13	1.60	1.13	1.83	0	0
Sphagnum moss	96.7[2]	100.0	24.7	23.2	1.04	1.63	1.14	2.63	0	0
Wood shavings	100.0	96.7[2]	34.7	27.2	1.10	1.40	1.10	2.04	0	0

[1]At end of 44 days 13.3 per cent of seed pieces were still dormant.

[2]At end of 44 days 3.3 per cent of seed pieces were still dormant.

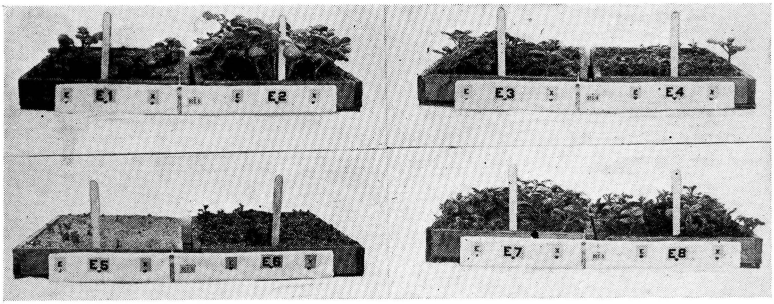

Figure 5.—Sprout growth from ethylene-chlorhydrin-treated (left) and check potatoes (right) planted in different soils. Pictures were taken 30 days after planting. Soils used were: E1, garden soil; E2, composted soil; E3, 67 per cent compost, 33 per cent sand; E4, 33 per cent compost, 67 per cent sand; E5, pure river sand; E6, coarse sawdust; E7, sphagnum moss, E8, peat (latter abnormal because of an accident).

Among the checks the small seed pieces grew most promptly and produced the most sprout growth within 42 days (Table 7). Among the treated, the response was most prompt and greatest with the largest pieces, and the weight of the sprouts was double that of the sprouts of the smallest pieces.

The prompt growth of the small untreated seed pieces was probably due to the fact that their eyes were in closer proximity to the cut surfaces than were those of large pieces. The larger cut surface of the large seed pieces and the resultant slower healing of the total surface gave more opportunity for gas to penetrate these pieces and to activate the tissues. The cut surfaces that were some distance from the periderm did not suberize as rapidly as those close to the periderm.

TABLE 7.—*Effect of seed-piece size on sprout growth, when all pieces were cut from tubers of the same size*

Weight of seed pieces (grams)	Mean number per seed piece				Total weight of sprouts per seed piece (grams)		Mean number of days for emergence	
	Sprouting eyes[1]		Sprouts above ground					
	Check	Treated[2]	Check	Treated[2]	Check	Treated[2]	Check	Treated[2]
15	1.0	1.1	1.0	1.1	22.4	24.1	28.4	27.7
30	1.1	2.0	1.0	2.3	20.0	44.3	30.5	18.8
60	1.4	2.7	1.0	2.6	13.4	48.8	37.1	21.4

[1]Number of eyes greater than of sprouts because all growing eyes were counted in this test, but sprout numbers represent only those that were above ground.

[2]Ethylene chlorhydrin treatment.

Apparently the effectiveness of the ethylene chlorhydrin treatment increases as the size of the seed piece increases, up to a certain size but not greatly beyond that size.

Position of the eyes on the tuber as a factor affecting growth response in dormant potatoes.—In view of the fact that in tubers that are apically dominant the apical eyes sprout most promptly, it was thought desirable to determine whether the response of apical and basal eyes of dormant tubers to ethylene chlorhydrin differs. For this purpose small seed pieces in the shape of triangular pyramids were cut out of both the apical and basal ends of medium-sized Triumph tubers. One hundred seed pieces of each type were secured, and half of each were treated with ethylene chlorhydrin on October 31, 1929. All were planted on November 1 and grown in the greenhouse for 41 days. The 50 pieces of each lot were distributed into six flats with an equal number of apical and basal end pieces in separate rows in each flat. The mean weight of the 100 pieces of each type were as follows: apical, 13.9, and basal, 14.3 grams.

The plants from the apical pieces emerged practically five days earlier than those from the basal pieces (Table 8). The percentage of pieces producing sprouts by the end of 41 days was higher from the apical pieces. There was little difference in the number of sprouting eyes or sprouts per seed piece.

When treated with ethylene chlorhydrin the growth of both apical and basal pieces was accelerated according to the data depicted in the sprout-emergence curve (not published) except that the apical pieces responded more slowly than the basal pieces, as indicated both by the mean emergence date and sprout-emergence curves.

TABLE 8.—*Sprouting record of apical and basal seed pieces cut from the same seed tubers*

Location of seed piece in parent tuber	Mean weight of seed pieces (grams)	Percentage of seed pieces producing sprouts	Average number of days for sprout emergence	Mean number of sprouts per seed piece	Percentage of seed pieces over ¾ rotten	Mean weight of tops from each seed piece (grams)
UNTREATED CHECK						
Apical pieces	13.9	74	24.4	1.00	66	19.3
Basal pieces	14.3	52	29.2	1.00	66	18.0
TREATED WITH ETHYLENE CHLORHYDRIN						
Apical pieces	13.9	98	19.9	1.53	58	28.3
Basal pieces	14.3	92	13.1	1.48	50	34.4

Apparently apical seed pieces of dormant tubers sprouted more promptly than basal pieces when not treated but less so when treated with ethylene chlorhydrin.

Sprout growth of irrigated and dry-land seed potatoes.—Dry-land and irrigated seed potatoes of the same line were planted on November 15 and also December 1, 1929, to determine whether culture caused any difference in dormancy of the tubers. The dry-land lot was in this instance probably the least mature, the irrigated plants having been more severely

TABLE 9.—*Sprout growth of irrigated and dry-land-grown seed potatoes tested on two dates in the fall of 1929*

Culture	Portion of seed pieces	Average number days to emergence date when planted		Mean number of sprouting eyes per seed piece		Mean number of sprouts per seed piece	
		Nov. 15	Dec. 1	Nov. 15	Dec. 1	Nov. 15	Dec. 1
Irrigated	Apical	22.3	30.7	1.2	1.9	1.3	2.0
	Basal	23.8	33.4	1.2	1.8	1.2	1.6
	Mean	23.1	32.1	...	...	...	...
Dry land	Apical	24.7	29.6	1.1	1.3	1.1	1.5
	Basal	26.1	32.5	1.1	1.9	1.1	1.5
	Mean	25.4	32.1	...	...	...	...

damaged by an early September frost. The apical and basal end pieces were planted separately. Fifty pieces of each were used.

The irrigated stock emerged somewhat more promptly when planted November 15, but later when planted December 1 (Table 9). The difference was not very great in either instance. The irrigated stock apparently was capable of producing more sprouts per seed piece than the dry-land stock. The apical pieces sprouted more quickly than did the basal pieces.

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